



LEADEx Airborne Surface Temperature Measurements  
by Infrared Radiometers  
Final Technical Report, ONR Grant N00014-92-J-1345



## Objectives

The instrument package flown on the Twin Otter was designed to provide data for the surface energy balance, ice thermodynamics, and atmospheric radiative transfer. The primary objectives were:

1. To measure the spatial distribution of ice surface temperature in a variety of atmospheric conditions. Data were obtained with a Heimann KT-19 infrared thermometer with a 2° field of view. This information can be used to infer the ice thickness distribution for thin ice and to validate estimates of ice surface temperature from satellite data.
2. To measure the broad-band radiative properties of suspended ice crystals or 'diamond dust' and determine the effects of these crystals on the surface infrared radiation balance and satellite-derived surface temperatures.
3. To observe the effects of heat and ice crystal plumes from leads on surface temperature downwind of the lead.
4. To obtain a complete suite of radiation flux measurements to validate satellite-derived estimates and evaluate the representativeness of point measurement, which are often used to validate area-average flux estimates.
5. To measure low-level atmospheric stratification to compare to TOVS-derived estimates. Knowledge of the boundary-layer stratification is needed to calculate surface fluxes of heat, water vapor, and momentum.

## Instrumentation

The Twin Otter's primary function was to provide logistics support for the ice camp, but when space was available, a removable rack of instruments was flown. The Otter's normal cruising speed is 50 ms<sup>-1</sup>, and data were recorded at 1 Hz, except for the surface skin temperature which was recorded at 80 Hz. The compliment of instruments included:

navigation  
altitude  
pitch and roll  
ambient air temperature  
surface skin temperature  
up and downwelling solar flux  
downward infrared flux  
infrared images  
video

GPS  
GPS and altimeter  
two-axis tilt sensor  
R.M. Young thermistor  
Heimann KT-19 infrared thermometer  
Kip and Zonin pyranometer  
Eppley pyrgeometer  
Agema 880LW infrared scanner  
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## Summary

Thanks to the close cooperation of the LEADDEX management team, the airborne surface temperature observations yielded a wealth of data even though no dedicated aircraft time had been allocated to that activity. The total lengths of radiometer and IR scanner profiles logged are about 5000 km by the Twin Otter chartered by the Polar Science Center, and 23,000 km by the University of Washington Convair C-131.

Some of the data reduction, primarily comparisons with satellite observations, is in progress with support from other agencies. However, the main task of checking the aircraft data and summarizing them in a suitable format remains to be done.

All flight data have been logged and annotated as shown on page 3..

At the bottom of each figure is the Julian date and time of the flight. The variables shown in the time series are as follows: LW\_up is the flux measured by the upward-looking pyrgeometer; SW\_up and SW\_dn are solar fluxes from the upward- and downward-looking pyranometers; T\_air and T\_ir are the ambient air and surface skin temperatures; Pitch and Roll are aircraft orientation in degrees from horizontal; Heading is the magnetic heading of the aircraft; Gnd Speed and Altitude are the aircraft speed over the ground and altitude from the GPS. Note: calibration of the radiation flux measurements have not been completed; flux data are presented here to afford a qualitative interpretation of the environmental conditions. Also note that the SW\_up is very sensitive to aircraft pitch and roll.

Preliminary comparisons of satellite-derived and KT-19-measured ISTs indicate that diamond dust is a serious problem in retrieving IST from space. Discrepancies of up to 8K are observed when the near-surface temperature inversion is strong and clear-sky ice-crystal precipitation is observed. Due to the small optical depth of the haze layer and its subtle contrast with the ice surface, satellite sensors may not be able to identify the existence of diamond dust. We are, however, exploring techniques to detect it either directly using multispectral measurements from AVHRR and TOVS, or indirectly by identifying the overall conditions in which diamond dust is likely to occur.

TOVS data for 14 of the flight days have been acquired from NESDIS and processed at the Polar Science Center using the French '31' algorithm.

Statement A per Telecon  
Dr. Thomas Curtin ONR/Code 1125  
Arlington, VA 22217

NWW - 23 Aug 93

Washington Univ., Seattle.

Per Telecon ONR 8/30/93

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